

Injuries and Injury Prevention among Senior Military Officers at the Army War College

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Injuries and activities associated with injuries were extracted from a retrospective review of the medical records of officers attending the U.S. Army War College during academic years 1999 and 2000 (AY99 and AY00). In AY99, cumulative injury incidence (officers with one or more injuries) was 56%. The next year (AY00), there was command emphasis on injury reduction and education of students on injury prevention strategies. Cumulative injury incidence in AY00 was 44%, significantly lower than in AY99 ($p = 0.01$, risk ratio [AY99/AY00] = 1.3, 95% confidence interval = 1.1–1.5). Among activities that could be linked to injuries, sports were associated with 41% in AY99 and 45% in AY00. Recommendations for ongoing injury reduction include the following: (1) continued command emphasis and instruction on injury reduction techniques; (2) encouraging the use of semirigid ankle braces to reduce ankle sprains; (3) reducing the number of practice and game sessions in sports activities; (4) encouraging overrunning of second and third base in softball; (5) prohibiting contact with the center line below the net in volleyball; and (6) encouraging medical care providers to record the activity associated with each injury in the medical records.

Introduction

For a carefully selected group of senior military officers, the final phase of formal military education involves matriculation at the U.S. Army War College (AWC). Officers attending the AWC spend most of their duty hours in seminar group discussions, lectures, reading, writing, and participating in selected field trips. They also take part in institutionally organized sports activities, which include softball, basketball, and volleyball. They may, in addition, participate in other sports, and almost all are involved in routine exercise, such as running and resistance training, because of the mandatory requirement to pass fitness tests on an annual or biannual basis. Compared with other individuals of similar age, these military officers tend to be much more physically active, have higher levels of physical fitness, and score higher on measures of type A behavior.^{1–5}

Although the benefits of regular physical activity are well known,⁶ physical activity also involves some risk of injury.^{7–10} Individuals who score high on questionnaires designed to mea-

sure type A also appear to be more likely to experience injuries than those scoring lower.^{11,12} At the AWC in academic year 1999 (AY99), medical personnel noted an estimated 66% increase in physical therapy consultations. The U.S. Army Center for Health Promotion and Preventive Medicine was called upon to conduct an epidemiological consultation to more fully define the injury incidence and possible causes of injury. The following academic year, personnel at the AWC attempted to reduce the injury rate through a variety of interventions involving command emphasis and educational efforts. Center for Health Promotion and Preventive Medicine personnel returned near the conclusion of this second year to determine whether injury rates had changed. This article describes the methods used to collect injury-related data, defines the injury rates at the AWC during 2 consecutive years, outlines the injury reduction measures undertaken, and provides further suggestions for injury control.

Methods

The medical record folders (Department of the Army [DA] Form 3444-6) of military students at the AWC are maintained at the Dunham Army Health Clinic at Carlisle Barracks, Pennsylvania. In May 1999 (at the end of AY99), these records were screened for the 10-month period students were at the AWC. For each visit to a medical care provider, the date of visit, diagnosis, anatomic location, activity when injured (if available), and disposition (final outcome of the visit) were extracted. This information was typically available on one of three forms: (1) Screening Note of Acute Medical Care (DA Form 5181-R); (2) Chronology of Medical Care (Standard Form 600); or (3) Emergency Care and Treatment Form (Standard Form 558).

In addition to injury data, other information regarding the students' physical characteristics and physical fitness were obtained. The most recent DA Form 88 (Report of Medical Examination) in the medical records provided information on gender, date of birth (for age calculation), stature, and body mass. Body mass index was calculated as body mass/stature².¹³ Army Physical Fitness Test (APFT) data were obtained directly from the Army Physical Fitness Test Score Card (DA Form 705); raw scores for push-ups, sit-ups, and the 2-mile run were extracted. The push-up and sit-up results were the maximum number that could be completed in separate 2-minute periods. For the 2-mile run, time to complete the distance was the performance measure.¹⁴ Students took the initial APFT approximately 3 months after their arrival at the AWC; the final test was taken approximately 1 month before departing the AWC.

Preliminary analyses of the AY99 data were presented to the AWC commandant and staff in July 1999, and the commandant provided his support for injury reduction efforts. During the

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next academic year (AY00), the staff of the AWC took the following specific steps to reduce injury rates. Information on the results of the AY99 project was provided to the AY00 students in their "welcome packets" before their arrival at the AWC. This information included a short memorandum addressing the injury rates and the need to train and warm up properly for specific sports, especially softball, because this was the first institutionally organized sport in the academic year.

Each student received a two-page educational handout discussing the unique differences of softball and what specific training was required to minimize or prevent injury. They were also given exercise handouts on strength training for softball that included pictures as well as written instructions. At the student orientation at the beginning of AY00, both the AWC commandant and the director of the Army Physical Fitness Research Institute stressed the need for injury control, and students were verbally briefed on the high injury rate from the previous year. Injury issues were further addressed with leaders at the start of AY00. Classes were provided on aerobic conditioning, strength training, spinal stabilization, and injury prevention during the autumn and winter months. About one-third of the class attended special elective courses that covered injury prevention issues. It should be noted that this was not a well-controlled intervention; rather, it was a combination of both planned and opportunistic efforts that arose during AY00 in the AWC setting.

To determine whether there was a difference in injury rates in AY00, medical records were again screened and APFT scores were collected in May 2000. The methods used to obtain these data were identical to those used in AY99, so direct comparisons could be made between years.

AWC Student Populations

The AY99 and AY00 populations were two entirely separate groups of students. The AY99 resident class consisted of 318 students, 249 of whom were U.S. military officers. The AY00 resident class consisted of 337 individuals, 264 of whom were U.S. military officers. Medical information on civilians attending the AWC was not available because civilians did not obtain routine medical care in Army clinics and their medical records were not available. International fellows (officers from other nations) attending the AWC did not have complete medical records and often differed considerably from U.S. officers in terms of health and fitness. A decision was made to exclude civilians and international fellows from this project for these reasons.

Injury Case Definitions

An injury was defined as an event that resulted in physical damage to the body¹⁵ for which the student had a documented

visit to a medical care provider. Injuries could be caused by overuse (repetitive energy exchanges resulting in cumulative microtrauma), acute trauma (sudden energy exchanges resulting in sudden overload trauma), or environmental factors. Overuse injuries included musculoskeletal pain (not otherwise specified), stress fractures, tendinitis, bursitis, fasciitis, and overuse syndromes. Traumatic injuries included pain (not otherwise specified but from a traumatic event), strains, sprains, dislocations, fractures, abrasions, lacerations, and contusions. Environmental injuries included heat injuries, cold injuries, and insect bites.

A new injury visit (or new injury) was defined as the first visit to a medical care provider for a specific injury. A single student could have more than 1 new injury. A follow-up injury visit (or follow-up injury) was a subsequent visit to a provider for the same injury.

Data Analysis

Cumulative injury incidence was calculated as the number of students with one or more injuries during an academic year (numerator) divided by the number of students whose medical records were screened in that same academic year (denominator). Cumulative injury incidence was calculated for all injuries, overuse injuries, and traumatic injuries. Injury rate was calculated as the number of new injury visits (numerator) divided by the number of students and multiplied by the number of months (denominator).

Where frequency data were compared (number of cases), the Pearson χ^2 statistic was used to test the hypothesis of no difference between groups; where expected cell sizes were less than 5, Fisher's exact test was used. Where continuous data were analyzed, the independent sample *t* test was used to compare groups.

Results

In AY99, medical records were obtained and reviewed for 230 of the 249 U.S. military students (92%). In AY00, medical records were obtained and reviewed for 228 of the 264 U.S. military students (86%). These 458 students were defined as the cohort, and only these individuals were considered in the subsequent analyses.

Injuries

Table I shows a comparison of the cumulative injury incidence in the cohort during the two 10-month periods. The cumulative incidence of injuries of any type was higher in AY99 than in AY00. The incidence of overuse injuries was approxi-

TABLE I

CUMULATIVE INJURY INCIDENCE AMONG SENIOR MILITARY OFFICERS AT THE AWC DURING AY99 AND AY00

Injury Type	Injury Incidence (%)		Relative Risk ^a (95% CI)	<i>p</i> ^b (AY99 vs. AY00)
	AY99	AY00		
All injuries	55.7	44.3	1.3 (1.1-1.5)	0.01
Overuse injuries	44.3	22.4	2.0 (1.5-2.6)	<0.01
Traumatic injuries	22.6	29.4	0.8 (0.6-1.1)	0.10

^aAY99/AY00; CI, confidence interval.

^bFrom χ^2 statistic.

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mately twice as high in AY99 than in AY00. There was a slight increase in the incidence of traumatic injuries in AY00.

In AY99, there were 169 new injury cases, and in AY00, there were 145 new injury cases. In AY99, the injury rate was 7.3 injuries/100 student-months, and in AY00, the rate was 6.4 injuries/100 student-months.

There were 14 women in the AY99 class and 15 women in the AY00 class. Although a greater proportion of men was injured compared with women, these gender differences in injury incidence were not statistically significant, as shown in Table II.

Activities Associated with Injuries

Table III shows the activities associated with new injury cases. An associated activity was not listed in the medical records in 47% of the injury cases in AY99 and in 40% of the cases in AY00. Sport or exercise activity was associated with 41% of new injury cases in AY99 (70 of 169) and with 45% of new injury cases in AY00 (65 of 145). Among the sports, softball and basketball were most often related to injury. The category "other sports" in Table III included racquetball, soccer, skiing, hockey, weight lifting, hunting, climbing, and bowling. The category "other activities" in Table III included falls (walking, going down stairs, or not specified), moving furniture, motor vehicle crashes, and striking objects. The "environmental" category was for insect bites and a cold injury.

The major types of injuries associated with specific sports in AY99 were as follows: softball-associated injuries included 11 strains (4 hamstrings), 7 contusions, 4 sprains, and 2 fractures; basketball-associated injuries included 7 contusions, 4 strains, and 3 fractures; and volleyball-associated injuries included 3 strains and 2 ankle sprains. The major types of injuries associated with specific sports in AY00 were as follows: softball-associated injuries included 6 strains (3 hamstrings), 7 contusions, and 3 fractures; basketball-associated injuries included 3 ankle sprains, 2 strains, and 2 fractures; and volleyball-associated injuries included 2 sprains.

Overall, there was a decrease in the number of injuries associated with institutionally organized sports (i.e., softball, basketball, and volleyball) in AY00 but an increase in injuries associated with other sports, exercise, and physical training. The numbers of institutionally organized sport-associated injuries were 51 and 39 in AY99 and AY00, respectively. Other sport-, exercise-, and physical activity-associated injuries were 19 and 26 in AY99 and AY00, respectively.

Physical Characteristics and Physical Fitness

Table IV shows a comparison of physical characteristics and APFT raw scores of the officers in AY99 and AY00. Only U.S. Army officers had APFT scores, because officers from other ser-

vices took other types of fitness tests and these scores were not available. Army men and women were separated in these analyses because of the large gender differences in most of the measurements. Men in AY00 were taller and heavier than men in AY99, but there were no differences in body mass index between the two groups. There were no differences in the male officer APFT scores between the two years. Women tended to be shorter and lighter in AY00, but their stature and body mass did not differ significantly from those of the female officers in AY99. Women in AY00 were more fit than women in AY99 as measured by the initial APFT. When men and women were combined in the analysis, there were no differences in any of the APFT events between the AY99 and AY00 Army officer groups.

Discussion

The cumulative injury incidence was 21% lower in AY00 compared with AY99. However, caution must be exercised in ascribing the decline in injuries directly and totally to the interventions undertaken during AY00. There is little historical information on injury rates before this project, and the lower injury rates in AY00 could merely represent a normal fluctuation from one year to the next at the AWC. One study¹ did examine injury incidence among AWC students in AY92 using methods identical to those of the present project. In AY92, a cumulative injury incidence of 28% was found, significantly lower than both the AY99 and AY00 rates, as shown in Table V.

The lower injury rate in AY92 may be attributed partly to fewer game and practice sessions in sports activities in that year. At the AWC, teams for institutionally organized sports are based on "seminar groups." Seminar groups are parties of 16 individuals who participate together in most academic and social activities, including sports. Games for each sport are played in a round-robin manner such that each team (seminar group) plays all of the other teams. In AY92, 17 competitive games were played. In AY99 and AY00, 19 competitive games were played (an 11% increase). Competitive games against other teams result in a higher injury incidence than practice sessions.¹⁶⁻¹⁹ The additional competitive games played in AY99 and AY00 may account for a portion of the increased injury incidence in both years compared with AY92.

Certain physical characteristics and fitness measures have been shown to be associated with injuries in some military populations.⁹ However, the small differences in these measures between the AY99 and AY00 students were unlikely to account for the differences in injury incidence in the two years. Men in AY00 were taller and heavier than men in AY99, but the two groups had similar body mass indexes, suggesting similar body fat.¹³ AY00 women tended to be lighter and more fit than AY99

TABLE II
COMPARISON OF CUMULATIVE INJURY INCIDENCE AMONG MEN AND WOMEN

Injury Category	AY99			AY00		
	Men (%)	Women (%)	<i>P</i> ^a	Men (%)	Women (%)	<i>P</i> ^a
All	56.9	35.7	0.12	44.6	33.3	0.40
Overuse	44.9	35.7	0.50	23.0	13.3	0.39
Traumatic	24.1	7.1	0.12	30.0	20.0	0.41

^aFrom χ^2 statistic comparing men and women.

TABLE III
ACTIVITIES ASSOCIATED WITH NEW INJURY CASES IN AY99 AND AY00

Activity	AY99		AY00	
	Associated Injuries (n)	Proportion of AY99 Total (%)	Associated Injuries (n)	Proportion of AY00 Total (%)
Softball	28	17	23	16
Basketball	17	10	12	8
Volleyball	6	4	4	3
Running	7	4	7	5
Other sports	10	6	15	10
Physical training	2	1	4	3
Other activities	15	9	21	14
Environmental	4	2	1	1
Unknown (not listed)	80	47	58	40

TABLE IV
COMPARISON OF OFFICER PHYSICAL CHARACTERISTICS AND APFT RAW SCORES IN AY99 AND AY00

Variable	Men			Women		
	AY99	AY00	<i>p</i> ^a	AY99	AY00	<i>p</i> ^a
Age (years)	43.1 ± 2.5	43.5 ± 2.8	0.14	45.6 ± 5.1	44.3 ± 2.8	0.46
Stature (cm)	178.8 ± 6.6	180.6 ± 6.9	<0.01	164.8 ± 8.1	162.3 ± 7.1	0.40
Body mass (kg)	85.4 ± 9.5	87.6 ± 10.9	0.03	67.6 ± 10.9	61.4 ± 7.7	0.12
Body mass index (kg/m ²)	26.5 ± 2.3	26.7 ± 2.4	0.46	24.7 ± 2.3	23.3 ± 2.4	0.15
Initial push-ups (n)	58 ± 17	57 ± 14	0.64	25 ± 11	40 ± 7	<0.01
Initial sit-ups (n)	61 ± 16	62 ± 16	0.51	52 ± 13	67 ± 9	0.02
Initial 2-mile run (minutes)	15.4 ± 1.5	15.4 ± 1.4	0.79	19.8 ± 1.8	17.3 ± 1.3	<0.01
Final push-ups (n)	57 ± 16	57 ± 13	0.97	23 ± 7	37 ± 9	0.02
Final sit-ups (n)	63 ± 15	63 ± 14	0.83	58 ± 13	66 ± 13	0.17
Final 2-mile run (minutes)	15.1 ± 2.1	15.4 ± 1.6	0.17	19.2 ± 2.3	17.5 ± 1.9	0.10

^aFrom independent sample *t* tests comparing AY99 and AY00.

TABLE V
HISTORICAL INFORMATION ON CUMULATIVE INJURY INCIDENCE AMONG MALE OFFICERS AT THE AWC

Year	Officers (n)	Injury Incidence (%)	Comparison with AY92	
			<i>p</i> ^a	Relative Risk (95% CI) ^b
AY92 ¹	198	28	—	—
AY99	230	57	<0.01	2.0 (1.6–2.6)
AY00	228	45	<0.01	1.6 (1.2–2.1)

^aFrom χ^2 comparing injury incidence in AY92 vs. AY99 or AY00.

^bRisk ratio = AY99/AY92 or AY00/AY92. CI, confidence interval.

women, but their injury incidence was similar in both years. Women made up a small proportion of the total cohort in both years (6–7%), and when combined with the male data, the AY00 and AY99 groups did not differ in terms of fitness.

It is possible that the lower injury rate in AY00 was attributable to the injury reduction efforts undertaken. These included a combination of education, command emphasis, and peer group involvement. The literature indicates that, alone, educational efforts directed at injury reduction have very limited success.^{20–23} On the other hand, what have been termed “community-based approaches”²⁴ have shown more promise in reducing injuries. Community-based approaches combine aspects of educational efforts with community leadership participation, modification of attitudes, behaviors, and norms,

and alterations in the physical environment.^{25–28} One major problem with community-based approaches is the limited ability to determine the effectiveness of individual interventions and thus to isolate the most effective ones.^{26–28} However, multiple strategies may be effective because different individuals respond to different aspects of the program.

The AWC community consisted of a unique population of well-educated and presumably well-motivated officers who were likely to listen to and act on the injury-reduction emphasis and advice. The military culture consists of a hierarchical structure of individuals who are responsive to well-articulated professional expertise. Access to the officers was easily accomplished because the population was well defined (even before their arrival at the AWC), all officers were often together in a single auditorium, mailboxes were located in one place, and each group of 16 officers had a seminar chair who could be contacted for group announcements. These factors must be considered when trying to generalize our results to other populations.

The decline in overall injury rates in AY00 (compared with AY99) was attributable primarily to a reduction in overuse injuries, because the incidence of traumatic injuries actually increased slightly. Much of the educational advice was exercise- and sports-oriented and involved recommendations on reducing these types of injuries (e.g., warm up before activity, treating minor muscle soreness, cross-training, sport-specific aerobic, strength, and flexibility training, proper sport equipment, etc.).

It is not clear why there was a reduction in injuries associated

with institutionally organized sports in AY00 but injuries among the other sports, exercise, and physical training increased. It is possible that the AY00 class was more physically active in sports and exercise outside of the AWC environment, but there are no data to support this.

Activities Associated with Injuries

One of the major findings of this investigation was that sports activity was associated with more than 40% of all injuries in both academic years. This was despite the fact that an almost equal proportion of injuries could not be linked to an activity because no activity was recorded in the medical records. It has been demonstrated that greater participation in sporting activity increases the risk of injury,⁷⁻¹⁰ probably because of greater exposure to potential injury-producing events. Thus, it should not be surprising that sports and exercise accounted for so many injuries in this group. The few studies that have examined causes of injury in military populations indicate that sport-related activity accounts for 19% to 51% of all injuries^{29,30} and 11% of hospitalizations.³¹

Recording of events associated with injury is extremely important from a prevention perspective. Events proximate to the injury provide a starting point in developing strategies for injury reduction. This is well illustrated in the present project, in which, despite missing information, sports-related events seem to play a major role in the genesis of injuries. The proximate event is most easily placed in the subjective portion of the SOAP (subjective, objective, assessment, plan) profile in the medical record, and medical care providers should be encouraged to report this information. Medical surveillance systems currently in development (e.g., Composite Health Care System II) also should include this type of information.

Additional Injury Reduction Suggestions

At the AWC, sports-related injuries should be a major target for continuing injury reduction efforts, because injury rates remained relatively high in AY00. Sports-related incidents also appear to account for a large proportion of injuries elsewhere in the military.²⁹⁻³¹ The following injury reduction suggestions were not implemented during AY00 because they were provided too late in the academic year. (See "Methods" for interventions that were implemented.) Suggestions included warm-up activity before sports, reducing the number of practice and game sessions, and sport-specific proposals as described below.

Stretching before activity has been advocated to reduce injuries, but the literature has not supported this as an effective intervention.^{32,33} On the other hand, task-specific warm up may have favorable physiological benefits that could reduce injury.^{34,35} Warm up differs from stretching in that stretching is largely designed to increase the range of joint motion, whereas task-specific warm up is directed at increasing temperature in the muscle groups to be used in the task.³⁵ Envisioning the tasks a player will perform can help develop appropriate task-specific warm-up activities. For example, a batter coming to the plate in softball may perform at least two tasks: swinging at the ball and running the bases. To warm up, the batter could practice swinging the bat (or bats) and some short sprints or running in place to warm up the appropriate muscle groups.

Reducing the number of practice and game sessions may also

reduce the number of injuries. A greater level of participation in sports activity has been shown to be associated with higher injury rates.⁷⁻¹⁰

Sports-specific injury reduction measures also should be considered. In the present project, softball was the activity associated with the greatest number of injuries. Although we do not know the mechanism of these injuries, previous literature suggests that more than 90% of softball injuries are associated with sliding, catching balls, falling, and collisions with fixed objects and other players.^{36,37} Injuries caused by sliding into bases can account for 42% to 71% of all softball injuries.³⁶⁻³⁸ Sliding injuries can be reduced by the use of breakaway^{39,40} or compressive bases⁴¹ and possibly by instruction on proper sliding techniques. Allowing the overrunning of second and third bases may also be an effective intervention. Overrunning bases was allowed but not mandated at the AWC in both AY00 and AY99. Guidelines for overrunning could state that players be required to overrun in a straight line and turn to the right as he or she decelerates. Turning to the right signals umpires and opposing team players of the runner's intention not to continue on to the next base and the end of the play, whereas a turn to the left would signal continued play.

Reminding players to check the field periodically when running after balls may reduce injuries attributable to collisions with other players. They can also be encouraged to shout their intention to catch a ball so other players in the vicinity (who may also be chasing the ball) can know their location. Padding of poles, backstops, field walls, and other objects players are likely to contact may reduce injuries caused by collisions with fixed objects. Injuries resulting from falls may be reduced by proper field maintenance to decrease the number of holes and rough spots in play areas.⁴⁰

Basketball was associated with the second highest rate of injuries in this project. In the Army, basketball accounts for more sports-related hospitalizations than any other single sport.³¹ Ankle sprains are among the most common type of basketball injury reported in the literature,^{19,42} and this is in agreement with the findings in the present project, in which four ankle sprains were associated with basketball. Several studies have shown that the use of semirigid ankle stabilizers (Sports Stirrup, Aircast, Inc., Summit, New Jersey) or soft lace-up ankle braces (Swede-O, North Branch, Minnesota) is effective in reducing ankle sprains or the recurrence of ankle sprains among basketball players, soccer players, and football players.⁴³⁻⁴⁶ High-top shoes have also been advocated to reduce ankle sprains, but studies have not found them effective unless combined with ankle taping.^{47,48} In the decision to use taping, consideration must be given to cost, amount of time involved in taping an ankle, the skill of the individual doing the taping, and the number of ankle sprain cases.

Ankle sprains are also one of the most common types of volleyball injuries, accounting for 16% to 50% of all injuries in this sport.⁴⁹⁻⁵¹ In the present project, officers experienced three volleyball-associated ankle sprains. The literature suggests that ankle sprains often occur when a player attempts to block a spike and that blocker returns to the ground, landing on the foot of the spiker.^{16,49,50,52} A rule change that prohibits contact with the center line below the net may reduce volleyball-associated ankle injuries.^{16,52} One study showed a reduction in ankle

sprain rates after a program that involved injury awareness training, technical training on proper takeoff and landing technique for blocking and spiking, and balance board training for players with recurrent ankle sprains.⁵³ Serving, passing, setting, and digging have not been associated with high rates of volleyball injuries.^{16,51,52,54}

Conclusion

This project documented the injury rate among officers attending the AWC and demonstrated a reduction in injury rate from AY99 to AY00. This reduction was associated with command emphasis and educational efforts directed at reducing injuries. A large proportion of the injuries was associated with sports and exercise-related activities in both AY99 and AY00. Suggestions for further injury-reduction efforts include the following: (1) continued command emphasis on injury reduction and education on injury-reduction techniques (especially task-specific warm up); (2) a reduction in the number of practice and game sessions; (3) encouraging the use of ankle braces to prevent ankle sprains, especially among those that have had previous ankle sprains; (4) for softball, allowing overrunning of second and third bases (or the use of breakaway or compressive bases if sliding is allowed), padding of poles and other objects with collision potential, and field maintenance to reduce irregularities in the field; (5) for volleyball, a change in the rules prohibiting contact with the center line at any time; and (6) encouraging medical care providers to record in medical records activities associated with injuries.

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